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ENERGY ENGINEERING ANALYSIS PROGRAM

AT
WATERVLIET ARSENAL, NY

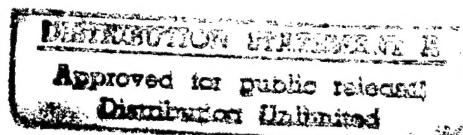


VOLUME I: EXECUTIVE SUMMARY

FINAL REPORT

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PREPARED BY

PRC SYSTEMS SERVICES
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UNDER

NORFOLK EEAP CONTRACT DACA-65-80-C-0014

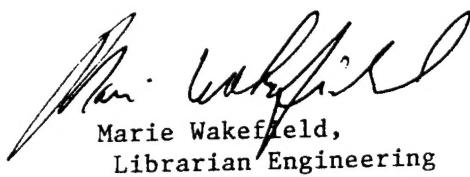


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EXECUTIVE SUMMARY

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
1.	INTRODUCTION	1
2.	EXISTING ENERGY CONSUMPTION	1
2.1	Basewide Energy Consumption	1
2.2	Historical Fuel Consumption	2
2.3	Building Type: Source Energy Consumption	2
2.4	Typical Building Energy Consumption	6
3.	INCREMENT A - BUILDINGS AND PROCESSES	6
3.1	ECIP Projects Developed	6
3.1.1	Architectural/Structural/Destratification Modifications	15
3.1.2	Solar DHW Heaters in Family Housing	16
3.1.3	Heating, Ventilating, and Air-Conditioning Systems Modifications	16
4.	INCREMENT B - UTILITIES, DISTRIBUTION SYSTEMS, AND ENERGY MONITORING AND CONTROL SYSTEM	17
4.1	ECIP Projects Developed	18
4.1.1	Modifications for EMCS	18
4.1.2	Electrical Distribution System Modifications	18
5.	INCREMENT C - RENEWABLE ENERGY SOURCES: SOLAR AND BIOMASS	18
6.	INCREMENT D - COGENERATION	18
7.	INCREMENT E - CENTRAL BOILER PLANT PROJECTS	19
8.	INCREMENT F - FACILITIES ENGINEER CONSERVATION MEASURES	19
9.	INCREMENT G - NONQUALIFIED INCREMENTS A AND B PROJECTS	19
9.1	Increment G Projects Developed	19
9.1.1	Weatherization Modifications	19
9.1.2	Weatherization Modifications in Family Housing	20
9.1.3	HVAC Modifications: Retrofit Electrostatic Precipitators	20
10.	ENERGY PLAN	21
10.1	Energy Usage per Square Foot	21

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
1	Historical Fuel Consumption	3
2	Administration, Operations, and Training Energy Consumption . .	7
3	Storage and Warehouse Energy Consumption	8
4	Theaters, Clubs, Recreation Centers, and Bowling Energy Consumption	9
5	Mess Hall, Snack Bar, Cafeteria, and Restaurant Energy Consumption	10
6	Barracks and BOQ Energy Consumption	11
7	Gas Station, Garage, Motor Pool, and Shops Energy Consumption .	12
8	Family Housing Energy Consumption	13
9	Other Energy Consumption	14
10	EEAP Project Summary	22

1. INTRODUCTION

This is the Corrected Final Report on Increments A, B, C, D, E, and G of the Energy Engineering Analysis Program (EEAP) at Watervliet Arsenal (WVLT). This project has been conducted under the Norfolk District, Corps of Engineers Contract No. DACA 65-80-C-0014, by PRC Systems Services, Cocoa Beach, FL.

During Increments A and B, five modification projects were recommended for funding under the Energy Conservation Investment Program (ECIP). Increment G resulted in three recommended projects and Increment E determined the feasibility of a new, coal-fired central steam plant. Studies conducted during Increments C and D concluded that none of the proposed work was economically feasible under applicable guidelines.

2. EXISTING ENERGY CONSUMPTION

Actual energy consumption at WVLT was determined from electricity billings and from fuel oil delivery records. Costs were taken from contracts and service agreements that were in force at the times the various increments were undertaken.

2.1 BASEWIDE ENERGY CONSUMPTION

Using conversion factors specified in the Army Facilities Energy Plan and prices in effect during the year, the following summarizes the total energy picture for fiscal year (FY) 82.

<u>Fuel</u>	<u>Consumption</u>	<u>Dollars</u>	<u>Source Energy Units</u>
Electricity	40,581,940 kWh	\$2,241,174	470,751 MBtu
Fuel Oil No. 2	193,662 gallons	247,887	26,861 MBtu
Fuel Oil No. 6	2,462,992 gallons	<u>2,677,165</u>	<u>368,685 MBtu</u>
		\$5,166,226	866,297 MBtu

2.2 HISTORICAL FUEL CONSUMPTION

Table 1 shows the historical record of fuel consumption from FY 75 through FY 82 and projected consumption for the future. The projection assumes that energy conservation measures recommended during this contract will have been completed and that the other factors (including base mission) remain constant. Not included are the anticipated effects of Increment E recommendations since the goal of that increment is not energy conservation, but rather cost reduction and conversion to a more plentiful and secure fuel.

2.3 BUILDING TYPE: SOURCE ENERGY CONSUMPTION

Buildings were grouped into 10 categories for the purpose of this study. Using FY 80 as the base year, the building groups were modeled on the computer to determine the relative consumption of each category. The following listing summarizes the results.

<u>Group</u>	<u>Title</u>	<u>Area (ft²)</u>	<u>Consumption MBtu</u>
I	Admin, Op, Trng	212,100	31,000
II	Stor, Whse	132,000	74,500
III	Rec, Clubs, Centers	3,800	1,100
IV	Mess Halls, Eating Estab	12,400	1,200
V	Clinic	0	0
VI	Barracks, BOQ	2,900	300
VII	Stores, Banks, Lib, Chap, Mus	0	0
VIII	Svce Sta, Gar, Mot. P, Shops	1,033,600	203,400
IX	Family Housing	130,300	12,000
X	Other, Audited	102,800	32,400
-	Other, Unaudited, Fuel Oil ¹	---	64,100
-	Other, Unaudited, Electricity ²	---	390,000

¹In addition to the unaudited buildings, this item accounts for oil to be saved because of base-initiated projects, and that used for processes.

²In addition to note 1, this item includes outdoor lighting and all pumps, fans, machines, and other equipment not subject to energy conservation measures.

Table 1. Historical Fuel Consumption

WATERMILL ARSENAL

	OCT '74	NOV '74	DEC '74	JAN '75	FEB '75	MAR '75	APR '75	MAY '75	JUN '75	JUL '75	AUG '75	SEP '75	OCT '75
TOTL. OIL #2 GM	5087	8660	10438	10411	14392	9116	10588	6510	1146	2538	717	2858	82461
TOTL. OIL #6 GM	20779	27088	332862	352459	244529	334911	239949	113591	56611	30877	53768	59538	2347668
TOTAL. KWH X 10 ³	2533	2380	2839	2672	2381	2678	2747	2834	2119	2693	2661	31287	

	OCT '75	NOV '75	DEC '75	JAN '76	FEB '76	MAR '76	APR '76	MAY '76	JUN '76	JUL '76	AUG '76	SEP '76	OCT '76
TOTL. OIL #2 GM	6913	1172	10958	11803	11690	9148	7986	1121	5824	190	6848	2839	88823
TOTL. OIL #6 GM	12970	194635	362239	436254	323317	310573	186610	143461	57291	28472	45871	69312	2292775
TOTAL. KWH X 10 ³	2679	2257	2831	2616	2464	2838	2599	2398	2844	1892	2880	2653	30980

	OCT '76	NOV '76	DEC '76	JAN '77	FEB '77	MAR '77	APR '77	MAY '77	JUN '77	JUL '77	AUG '77	SEP '77	OCT '77
TOTL. OIL #2 GM	6223	6316	14911	16550	21019	1398	5161	5040	4975	126	2445	20197	117564
TOTL. OIL #6 GM	216298	302413	39145	428267	331771	260558	18059	11218	62702	30952	37884	80174	2442731
TOTAL. KWH X 10 ³	2432	2817	2875	3084	2729	3022	2815	3030	3133	1995	3554	3496	35040

Table 1. Historical Fuel Consumption (cont)

WATERVLIET ARSENAL

	OCT 71	NOV 71	DEC 71	JAN 72	FEB 72	MAR 72	APR 72	MAY 72	JUN 72	JUL 72	AUG 72	SEP 72	OCT 72
TOTL. OIL #2 GAL	6150	12154	19195	12453	24178	10189	5865	1935	9914	168	1278	17389	129868
TOTL. OIL #6 GAL	197459	255805	319279	393679	353385	1132557	257540	131241	69106	38008	39530	41583	2559472
WATER, GAL X 10 ³	3249	3369	3421	3558	3015	3586	3111	3493	2480	3593	2497	3302	38927

	OCT 72	NOV 72	DEC 72	JAN 73	FEB 73	MAR 73	APR 73	MAY 73	JUN 73	JUL 73	AUG 73	SEP 73	OCT 73
TOTL. OIL #2 GAL	5193	3618	24815	21362	11504	50162	39265	3064	19952	28800	32422	43378	288125
TOTL. OIL #6 GAL	226059	354396	285442	4144486	435591	395390	227010	83775	58779	10975	46605	51367	2649875
WATER, GAL X 10 ³	3127	3231	35711	3596	3747	3501	3545	3234	3160	3427	2595	36411	40980

	OCT 74	NOV 74	DEC 74	JAN 75	FEB 75	MAR 75	APR 75	MAY 75	JUN 75	JUL 75	AUG 75	SEP 75	OCT 75
TOTL. OIL #2 GAL	30535	22882	50851	29198	30239	16719	33742	31861	30035	21558	30084	355371	
TOTL. OIL #6 GAL	159398	264477	257075	356328	314979	213942	165522	91471	56034	112351	46332	11235	2068597
WATER, GAL X 10 ³	3095	3606	3180	3355	3646	3161	3090	3122	3523	3184	2628	3283	38875

Table 1. Historical Fuel Consumption (cont)

	OCT 80	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
FUEL OIL #2 GAL	24188	24333	23730	50851	29200	28750	15800	28545	26670	25905	18009	24120	320,101
FUEL OIL #6 GAL	197716	263150	387607	356328	309894	325843	197621	96739	49066	22878	43247	55178	2,035,267
ELECT. KWH x 10 ³	3065	3050	3520	3353	3727	3186	3274	3316	3282	3043	2775	3371	38,960

	OCT 81	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
FUEL OIL #2 GAL	16005	17328	18918	27110	22109	35245	7809	5880	6909	7246	8917	20186	193,662
FUEL OIL #6 GAL	17509	247064	347460	505440	338873	323465	247693	78756	52563	24970	48164	51035	2,462,992
ELECT. KWH x 10 ³	3101	3131	3274	3491	3340	3340	3390	3411	3631	3520	3302	3650	40582

PROJECTED

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
FUEL OIL #2 GAL	16900	18500	26600	21700	34900	7400	5500	6500	6850	8500	18966	187916	
FUEL OIL #6 GAL	154355	217079	315778	211714	202087	154748	49203	32839	15600	30092	31885	1538775	
ELECT. KWH x 10 ³	3011	3041	3179	3390	3244	3244	3292	3312	3526	3418	3206	3544	39406

2.4 TYPICAL BUILDING ENERGY CONSUMPTION

Tables 2 through 9 show the consumption of energy for heating, cooling, and lighting for individual buildings (or zones of buildings). The arrangement of the buildings is by the categories listed in 2.3. (Note: Lighting energy is measured at the site; heating and cooling energy is measured at the sources.)

3. INCREMENT A - BUILDINGS AND PROCESSES

The following measures were investigated in detail during Increment A. Those in the column on the left did not meet ECIP criteria or were rejected for other reasons. Those on the right have been incorporated into one or more ECIP project packages.

Exterior Wall Insulation	Interior Wall Insulation
Domestic Hot Water (DHW) Timeclocks	Exterior Roof Insulation
DHW Temperature Setback	Interior Roof Insulation
Personnel Door Weather Stripping	Ceiling Insulation
Bay Door Weather Stripping	Underfloor Insulation
Interior Lighting	Basement Wall Insulation
Sensible Heat Economizers	Window Treating (including Weather Stripping)
Pipe/Duct Insulation	Destratification Fans
	Solar DHW
	Condenser Heat Recovery
	Exhaust Air Heat Recovery
	Outside Air Economizer

3.1 ECIP PROJECTS DEVELOPED

The following paragraphs describe the projects that have resulted from the Increment A portion of the study. The effects of the projects are summarized in section 10.

Table 2. Administration, Operations, and Training Energy Consumption

WATERVLIET ARSENAL

GROUP:	TITLE:	USE	HEATING CONSUMPTION			COOLING CONSUMPTION			LIGHTING CONSUMPTION		
			TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (X1000)	TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (X1000)	TOTAL ANNUAL SITE (MEGA BTU)	BTU PER SQ FT (X1000)	
P10A	5250	REPRODUCTION	287	63	64.7	10	3	1.9	19	3.6	
P10B	3091	ADP	111	26	35.9	273	59	88.3	72	23.3	
P10C	1790	OFFICE	111	29	62.0	0	0	0	2	1.1	
P10D	58659	ADMIN	1016	225	89.1	0	0	0	495	6.3	
P24	11400	SECURITY	664	147	105.2	0	0	0	91	8.3	
P40C	6314	ADMIN	554	119	145.0	0	0	0	14	14.4	
P40D	3820	REPRODUCTION	689	136	239.1	11	4	3.8	16	3.7	
P40E	2862	PERSONNEL	960	207	193.7	0	0	0	79	16	
P40F	4957	ADMIN	4464	996	213.7	0	0	0	170	15.9	
P40H	20809	CONF ROOM	152	33	70.5	1	0	0.5	2	0.5	
P40I	2157	OFFICE	120	26	317.5	1	1	2.7	7	0.9	
P40J	370	OFFICE	3271	718	222.3	0	0	0	162	18.5	
P40L	14716	OFFICE	1609	355	118.6	0	0	0	57	11.0	
P40M	13564	ADMIN	1100	240	161.0	0	0	0	0	4.2	
P40Q	6846	ADMIN	595	131	106.3	18	5	5.6	0	0	
P40R	3193	ADMIN	2061	451	150.7	0	0	0	0	0.6	
P40S	13672	GAGE BLDG	2047	621	94.9	13	1.1	34	34	11.4	
P44A	30000	COMPUTER	568	108	247.0	164	42	71.3	56	24.3	
P115B	2300	OFFICE	352	95	84.4	0	0	0	36	8.6	
P135B	4173	OFFICE	273	64	136.5	0	0	0	14	7.0	
P145A	2000										

Table 3. Storage and Warehouse Energy Consumption

WATERLIET ARSENAL

GROUP : 1	TITLE : STORAGE, WAREHOUSE	FLOOR AREA	USE	HEATING CONSUMPTION			COOLING CONSUMPTION			LIGHTING CONSUMPTION		
				TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (x1000)	TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (x1000)	TOTAL ANNUAL SITE (MEGA BTU)	BTU PER SQ FT (x1000)	
P40G	2024	21	STORAGE	10.4	0	0	0	0	0	53	26.2	
P120	93600	7711	STORAGE	82.4	0	0	0	0	0	470	5.0	
P130	20301	63883	STOREHOUSE	2250.9	0	0	0	0	0	133	4.7	
P145B	8000	531	WINE PROCESSING	66.4	0	0	0	0	0	49	6.1	

Table 4. Theaters, Clubs, and Recreation Center Energy Consumption

WATERLOO AREA

GROUP: III (THEATRES, CLUBS, RECREATION CENTERS)

Bldg. No.	NAME	USE	HEATING CONSUMPTION			COOLING CONSUMPTION			LIGHTING CONSUMPTION		
			FLOOR AREA (1000 FT ²)	TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (X1000)	TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (X1000)	TOTAL ANNUAL SITE (MEGA BTU)	BTU PER SQ FT (X1000)
1141	1152	OFF CLOS	614	182	217.0	15	6	4.0	65	17.3	

Table 5. Mess Hall, Snack Bar, Cafeteria, and Restaurant Energy Consumption
WATKINS ARSENAL

GROUP:	ITEM:	HEATING CONSUMPTION				COOLING CONSUMPTION				LIGHTING CONSUMPTION			
		TOTAL ANNUAL USE	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (x1000)	TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (x1000)	TOTAL ANNUAL SITE (MEGA BTU)	BTU PER SQ FT (x1000)				
IV	MESS HALL, SNACK BAR, CAFETERIA, RESTAURANT	11394 965	145 220	164 51	65.4 236.3	18 29	5 7	1.6 30.1	34 20				
P21000 P4000	RESTAURANT PX												3.0 20.7

Table 6. Barracks and BOQ Energy Consumption

WATERWELL ARSENAL

Group : VI UNIT : BARRACKS, BOQ

GROUP : VI	UNIT : BARRACKS, BOQ	HEATING CONSUMPTION			COOLING CONSUMPTION			LIGHTING CONSUMPTION		
		TOTAL ANNUAL MWh/1000	USEF	BTU PER SQ FT (X1000)	TOTAL ANNUAL (MWh/1000)	PEAK MONTH (MEGA WTH)	TOTAL ANNUAL (MWh/1000)	PEAK MONTH (MEGA WTH)	BTU PER SQ FT (X1000)	TOTAL ANNUAL SITE (MWh/1000)
P2100	1520	800	173	39	113.2	1	2	2.6	0	0
P2200	1406	800	140	30	99.6	0	0	0.7	0	0

Table 7. Gas Station, Garage, Motor Pool, and Shops Energy Consumption

WATERLOO ARSENAL

GROUP: VIII: 11100: GAS STATION, GARAGE, MOTOR POOL, SHOPS

Bldg/Zone	Floor Area (1000 ft ²)	Use	HEATING CONSUMPTION			COOLING CONSUMPTION			LIGHTING CONSUMPTION		
			TOTAL ANNUAL (MGA Btu)	PEAK MONTH (MEGA Btu)	Btu PER SQ FT (X1000)	TOTAL ANNUAL (MGA Btu)	PEAK MONTH (MGA Btu)	Btu PER SQ FT (X1000)	TOTAL ANNUAL SITE (MGA Btu)	Btu PER SQ FT (X1000)	
P15	22990	MOTOR POOL	4110	940	179.6	0	0	0	108	4.7	
P20A	96000	Shop	10027	4531	198.2	0	0	0	1046	10.9	
P22H11	6152	FIRE HOUSE	724	153	66.7	0	0	0	57	6.8	
P23	10220	Shop	2251	566	120.2	0	0	0	235	12.6	
P23H6A	61200	M/G SHOP	1591	360	26.0	0	0	0	1087	30.8	
P24H6	61200	M/G SHOP	1539	352	25.5	0	0	0	1179	19.3	
P24H6C	61200	M/G SHOP	15296	3392	249.9	245	94	4.0	1423	23.3	
P15A	169053	PT OF LINE BLDG	12446	2905	7.3	0	0	0	2423	14.3	
P4AH	1960	CONSTANT TEMP ROOM	202	59	100.8	30	9	19.2	2	1.3	
P4AC	2040	MACHINE ROOM	375	78	103.8	29	9	14.2	43	21.1	
P110	229925	CAR SHOP	24697	6129	109.8	0	0	0	2985	13.3	
P125	119340	M/G SHOP	16016	4094	134.2	0	0	0	1447	12.1	
P136A	106645	M/G SHOP	59293	13916	317.7	0	0	0	2418	13.0	

Table 8. Family Housing Energy Consumption
WATERLINE AUSTRAL

Group : IX	House Type : Family Housing	House Area : 0-500 SQ FT	WARMING CONSUMPTION			COOLING CONSUMPTION			WARMING CONSUMPTION		
			TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (X1000)	TOTAL ANNUAL (MEGA BTU)	PEAK MONTH (MEGA BTU)	BTU PER SQ FT (X1000)	BTU PER SQ FT (X1000)	ANNUAL SITE (MEGA BTU)	BTU PER SQ FT (X1000)
P3	9740	SINGLE	609	145	62.5	0	0	0	0	30	3.1
P6	15940	DUPLEX	934	216	61.6	0	0	0	0	120	7.5
P8	11173	DUPLEX	737	163	66.0	0	0	0	0	64	7.5
P9	2260	DUPLEX	203	69	126.2	0	0	0	0	32	14.2
P19	9200	MULTI	603	140	65.5	0	0	0	0	69	7.5
P40A	2775	DUPLEX	1033	214	372.3	0	0	0	0	21	7.6
P40B	3964	DUPLEX	974	205	245.7	0	0	0	0	21	5.3
P40D	2460	DUPLEX	166	42	67.5	0	0	0	0	18	7.3
P40J	2016	SINGLE	137	30	60.0	0	0	0	0	15	7.4
P41A*	9151	MULTI	396	98	43.3	0	0	0	0	68	7.4
P41J*	13795	MULTI	602	149	43.6	0	0	0	0	103	7.5
P450	2730	SINGLE	254	58	93.0	0	0	0	0	21	7.7
P452	3008	DUPLEX	239	61	62.8	0	0	0	0	28	7.4

* HOUSES AND OTHER SIMILAR BUILDINGS

Table 9. Other Energy Consumption
WATERLIFT ARSENAL

Group:	X	Type:	Other	HEATING CONSUMPTION			COOLING CONSUMPTION			LIGHTING CONSUMPTION		
				Total Annual (M.GA Btu)	Peak Month (M.GA Btu)	Btu per sq ft (x1000)	Total Annual (M.GA Btu)	Peak Month (M.GA Btu)	Btu per sq ft (x1000)	Total Annual (M.GA Btu)	Peak Month (M.GA Btu)	Btu per sq ft (x1000)
P200	9600	OFFICE	960	250	10.0	0	0	0	0	216	22.5	
P150	275	OFFICE	397	99	1443.6	34	12	123.6	131	131	476.4	
P40K	700	CLASSROOM	524	106	671.8	1	0	1.3	1.3	1	1.3	
P40W	649	PRODUCTION	220	48	351.3	2	1	3.1	2	2	3.1	
P115A	17700	WEAPONS DEV	16442	3462	211.6	114	60	1.5	649	649	8.4	
	140	TAO	1051	477	134.6	62	23	4.5	115	115	8.3	
	13776	TAO										
	1424											

3.1.1 ARCHITECTURAL/STRUCTURAL/DESTRATIFICATION MODIFICATIONS. Work will consist of the following modifications to achieve improved energy conservation:

a. Wall Insulation.

- (1) R5 spray cellulose in buildings P25, P145
R7 spray cellulose in buildings P25, P130
R9 spray cellulose in buildings P25, P135

- (2) R9 F/G batts in building P15
R13 F/G batts in building P135
R15 F/G batts in buildings P10, P22, P125
R17 F/G batts in building P41
R19 F/G batts in buildings P10, P22, P40, P41, P44

b. Ceiling (Roof) Insulation.

- (1) R15 blown-in F/G in building P10
R17 blown-in F/G in building P115

- (2) R9 lay-in F/G batts in building P44
R13 lay-in F/G batts in building P44

- (3) R19 exterior IRMA-type roof system on building P20

- (4) R19 exterior insulation and new shingles on building P110

c. Floor/Basement Insulation.

- (1) R9 spray cellulose on basement walls in building P10

- (2) R9 F/G batts and furring on basement walls in building P23

- (3) R9 F/G batts and mesh under floor of building P22

d. Steam Pipe Insulation. R4 F/G in building P41

e. Window Treatment.

- (1) Double glazing on building P40
- (2) R14 insulating curtains on buildings P10, P22, P23, P24, P25, P40, P41, P44, P135
- (3) R19 dryvit-type panels on windows in buildings P120, P35, and P124
- (4) Translucent sandwich panels on buildings P125 and P130
- (5) R19 dryvit-type panels over 80 percent of translucent area, R11 translucent sandwich panels over 16 percent, and double pane glass over 4 percent of the existing translucent areas of building P135

f. Destratification. Fans in buildings P20, P110, P125, P35

NOTE

The terms dryvit, IRMA, fiberglass (or F/G) as used herein are intended as descriptive terms only. They are used for brevity and clarity to indicate acceptable types of modifications. Any equivalent product may be utilized.

3.1.2 SOLAR DHW HEATERS IN FAMILY HOUSING. Work will consist of installation of solar DHW heaters and appropriate plumbing and instrumentation in Rotterdam family housing. In addition, for buildings P471 and P475, a small weatherproof cover will be constructed to house the new hot water tank.

3.1.3 HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC) SYSTEMS MODIFICATIONS.

- a. Building 25 - Exhaust Air Heat Recovery. Work will consist of modifications to the existing first and second floor outside air intake and exhaust air systems to provide for a glycol pumparound system as follows:

- (1) Install air-to-glycol coils in north and south penthouse air intake
 - (2) Install air-to-glycol heat recovery coils in the north and south general and toilet exhausts and the north elevator exhaust
 - (3) Install a pump/control center and assorted glycol piping with insulation and suitable controls
- b. Building 44 - Reduce Outside Air Intake. Work will consist of system modifications to HV-1 heating and ventilating system as follows:
- (1) Modify outside air intake duct for modulating dampers and air handler plenum to accommodate a return air duct with dampers
 - (2) Install a return air duct system from the zone to HV-1
 - (3) Modify controls and provide for damper modulation to control outside and return air in inverse proportions
 - (4) Provide exhaust fan control modifications for minimum, medium, and maximum ventilation modes to operate in conjunction with HV-1 damper controls.

4. INCREMENT B - UTILITIES, DISTRIBUTION SYSTEMS, AND ENERGY MONITORING AND CONTROL SYSTEM (EMCS)

The following measures were studied under Increment B:

- o Exterior lighting improvements
- o Steam/condensate system improvements
- o Electricity distribution system improvements
- o EMCS expansion

4.1 ECIP PROJECTS DEVELOPED

This paragraph describes the projects that resulted from the Increment B portion of the study. The effects of the projects are summarized in 10.

4.1.1 MODIFICATIONS FOR EMCS. Buildings at WVLT are to be modified to achieve improved energy conservation. Install EMCS to control and minimize energy consumption. Useful management data will be reported to reduce labor requirements and report malfunctions as well as minimizing energy consumption during building nonuse hours.

Controls and sensors will be installed in buildings 10, 15, 20, 21, 23, 24, 25, 35, 40, 44, 110, 115, 120, 124, 125, 130, 135, and 136.

4.1.2 ELECTRICAL DISTRIBUTION SYSTEM MODIFICATIONS. Project consists of reducing the capacity of transformers by moving several existing transformers to different substations and by installing new transformers where requirements indicate.

5. INCREMENT C - RENEWABLE ENERGY SOURCES: SOLAR AND BIOMASS

The feasibility of utilizing solar energy to supplement DHW heating, space heating, and a combination of water and space heating was analyzed during Increment C. No project in either the sample support building or in the sample family housing building proved acceptable under Increment C guidelines.

In the biomass portion of Increment C, the present economic viability of wood chips as a substitute fuel was determined. However, because of the uncertainty of supply and the potential volatility of the price, conversion to biomass as the primary fuel was not recommended. There are no other potential sources of renewable energy at WVLT.

6. INCREMENT D - COGENERATION

Four different steam pressure/temperature situations were analyzed in order to determine the feasibility of electric cogeneration. In each case, a superheater was required and outlet steam conditions had to be equivalent to current heating

system supply conditions. In none of the cases was the life cycle cost as low as that of the status quo. Therefore, no projects are recommended.

7. INCREMENT E - CENTRAL BOILER PLANT PROJECTS

Increment E resulted in the recommendation that a new, coal-fired, fluidized bed boiler plant be constructed near the site of the existing plant. Life cycle cost analysis (per applicable guidelines) clearly indicated the economic feasibility of coal firing versus oil.

8. INCREMENT F - FACILITIES ENGINEER CONSERVATION MEASURES

No Increment F study was authorized under this contract.

9. INCREMENT G - NONQUALIFIED INCREMENTS A AND B PROJECTS

Several projects that were originally considered under Increment A were re-analyzed under this increment. Those projects that are acceptable under Increment G criteria are described in the following paragraph. The effects of the projects are summarized in 10. One additional project, to combine the chilled water systems in buildings 115 and 120, was rejected again.

9.1 INCREMENT G PROJECTS DEVELOPED

9.1.1 WEATHERIZATION MODIFICATIONS. Work will consist of the following modifications to improve energy conservation:

- a. Wall Insulation. R7 interior spray in buildings P110, P120, P124
- b. Lighting Modification. Replace fluorescent with high-pressure sodium in buildings 15 and 130
- c. Window Area Modification.
 - (1) Replace deteriorated windows with same size double-glazed windows in building P10

- (2) Replace deteriorated windows with double-glaze windows to fill 40 percent of window opening and fill 60 percent with insulated 6-in stud wall in building P40
- (3) Cover deteriorated window area with 80 percent translucent sandwich panels and 20 percent double-glazed operable windows in building P110

9.1.2 WEATHERIZATION MODIFICATIONS IN FAMILY HOUSING. Work will consist of the following modifications to improve energy conservation:

a. Wall Insulation.

- (1) R15 interior batt in building P21
- (2) R17 interior batt in building P490
- (3) R19 interior batt in building P22

b. Basement Wall Insulation. R11 spray cellulose in building P490

- c. Insulating curtains in buildings P21, P22, P40, P460, P463, P490, P492
- d. Shower flow restrictors in buildings P460, P463, P471, P472, P473, P474, P475, P490, P492
- e. Automatic setback thermostats in buildings P460, P463, P470, P471, P472, P473, P474, P475

9.1.3 HVAC MODIFICATIONS: RETROFIT ELECTROSTATIC PRECIPITATORS. This project for building P125, Weld Shop, consists of modifications to the two existing exhaust systems to retrofit electrostatic precipitators for removal of contaminants and recirculation of a major percentage of the heated room air.

- a. Remove existing fan assemblies
- b. Install new fan/precipitator units
- c. Modify ducts and install new recirculated air supply ducts
- d. Install new modulating dampers in the outside air intake, exhaust, and recirculated air ducts with appropriate thermostatic controls

10. ENERGY PLAN

In FY 82, WVLT consumed 866,297 MBtu's of energy at a cost of over \$5 million. Implementation of all recommended projects except Increment E would reduce this consumption to 713,513 Btu's, which would cost less than \$4 million at comparable prices. Table 10 summarizes the recommended EEAP projects.

10.1 ENERGY USAGE PER SQUARE FOOT

The total area of buildings at WVLT is 1.7 million ft². On a gross basis, the consumptions in Btu's in FY 82 and after implementation of recommended projects are:

	<u>FY 82</u>	<u>Future</u>	<u>Δ</u>
Electricity	276,912 Btu/ft ²	268,888 Btu/ft ²	8,024 Btu/ft ²
Fuel Oil No. 2	26,861 Btu/ft ²	26,064 Btu/ft ²	797 Btu/ft ²
Fuel Oil No. 6	<u>368,685 Btu/ft²</u>	<u>230,339 Btu/ft²</u>	<u>138,346 Btu/ft²</u>
	672,458 Btu/ft ²	525,291 Btu/ft ²	147,167 Btu/ft ²

This represents an overall reduction of almost 22 percent in total energy consumption.

Table 10. EEAP Project Summary

<u>Project</u>	<u>Increment</u>	DD 1391 Information						Energy Savings			
		Project Year	CWE \$1,000	E/C	B/C	P/B	F0 #2	Ga Tons F0	F0 #6	Electricity kWh	Total MBtu
Architectural/Structural / Destratification Modifications	A	1984	5,310	13.8	2.7	9.1	0	504,603	-183,621	73,404	
Solar Assisted DHW	A	1984	383	2.4	0.4	18.9	2,588	0	48,621	923	
HVAC Systems Mods	A	1984	346	21.3	4.1	6.2	0	50,812	-20,259	7,371	
Install EMCS	B	1984	735	69.7	2.1	7.3	0	286,659	714,483	51,198	
Elec Dist Syst Mods	B	1984	304	20.1	2.7	7.9	0	0	525,603	6,097	
Weatherization Modifications	G	1984	1,728	6.6	1.7	14.9	0	72,964	34,914	11,327	
HVAC Modification	G	1984	123	9.5	1.8	14.8	0	7,950	-1,552	1,172	
Weatherization for Family Housing	G	1984	42	31.0	4.0	4.0	<u>3,158</u>	<u>1,229</u>	<u>57,845</u>	<u>1,293</u>	
Totals			5,746	924,217	1,176,034	152,785					